Translation of Published International Patent Application

NETWORK DEVICE

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DESCRIPTION

Technical Field

The present invention relates to network devices for connecting an optical fibre outside a structure and an optical fibre or other network terminal inside the structure, when building a new optical fibre based information network in an existing structure such as a house.

Technical Background

Hitherto, to lead an optical fibre inside an existing structure such as a house, it has been necessary either to lead the fibre in along an existing duct for telephone wires, or to lead it inside through a vent hole or a hole for air conditioning pipework exposed on the outside of the structure.

If the optical fibre is to be run along a duct, it may be impossible – depending on the nature of the duct – to lead it in, due for example to the fact that electrical wires are already in place and hence there is no space for the installation of the optical fibre; or it may be impossible to lead in the fibre because the radius of curvature of the pipework is small and therefore a tight bend would affect the transmission characteristics of optical fibre. Utilising a vent hole or a hole for pipework results in the optical fibre projecting from a wall, which is not desirable in terms of aesthetic appearance. Moreover, because the optical fibre is exposed, there is a risk that it could be damaged during use.

To overcome such problems, Japanese Kokai Patent Publication 11-089058 discloses embedding a wiring duct in a wall in advance. However, although a wiring duct can be embedded in advance in a new building, it cannot be embedded in an existing building.

The present invention has been devised to overcome the issues, described above, encountered with the prior art.

Disclosure of the Invention

The present invention provides a network device disposed within or in the vicinity of a through-hole formed so as to pass through a wall of a structure, and serving to connect, for purposes of signal transmission, an optical fibre located outside the structure and a network terminal located inside the structure, said network device comprising: (i) within or in the vicinity of the through-hole, a first optical connector part [1]* couplable to the network terminal, which is an optical fibre inside the structure; (ii) within or in the vicinity of the through-hole, a second optical connector part [2] couplable to the optical fibre outside the structure; and (iii) a connector which connects the first optical connector part and the second optical connector part.

The present invention also provides the aforesaid network device wherein the aforesaid connector comprises: (i) connected to the first connector part, a first photoelectric converter for interconversion of optical and electrical signals; (ii) connected to the second optical connector part, a second photoelectric converter for interconversion of optical and electrical signals; and (iii) a connecting line electrically connecting the first and second photoelectric converters.

The present invention also provides the aforesaid network device wherein the aforesaid connector is an optical fibre.

The present invention also provides a network device disposed inside or in the vicinity of a through-hole formed so as to pass through a wall of a structure, and which serves to connect, for purposes of signal transmission, an optical fibre located outside the structure and a network terminal located inside the structure, said network device comprising: (i) within or in the vicinity of the through-hole, an optical connector part couplable to the optical fibre outside the structure; (ii) connected to said optical connector part, a photoelectric converter for interconversion of optical and electrical signals; and (iii) a wireless communication device electrically connected to the photoelectric converter and capable of sending and receiving radio signals to and from the network terminal inside the structure.

The present invention also provides the aforesaid network device, wherein this network device comprises a wireless communication device capable of sending and receiving electrical signals to and from the aforesaid network terminal.

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* Numbers in square brackets refer to Translator's Notes appended to the translation.

The present invention also provides the aforesaid network device, wherein this network device comprises a wireless communication device capable of sending and receiving optical signals to and from the aforesaid network terminal.

The present invention also provides the aforesaid network device wherein an optical fibre and an electric power line for supply of electrical power are combined.

Brief Description of the Drawings

FIG. 1 is a schematic sectional view of the situation where a network device according to a first embodiment of the invention has been disposed in a through-hole of a wall of an apartment building, and of the situation where the end of an optical fibre inside the building has been connected to an optical connector part of the network device.

FIG. 2 is a schematic sectional view of the situation where a network device according to a second embodiment of the invention has been disposed in a through-hole of a wall of an apartment building, and of the situation where radio waves are sent and received to and from a network terminal inside the building by means of a wireless communication device of the network device.

FIG. 3 is a schematic sectional view of the situation where a network device according to a third embodiment of the invention has been disposed in a through-hole of a wall of an apartment building, and of the situation where electric power lines have been combined with an optical fibre cable outside the building.

Preferred Modes of Practising the Invention

The present invention is a network device for connecting, for purposes of signal transmission, an optical fibre located outside a structure and an optical fibre – which is a network terminal – located inside the structure.

In a first mode of practising this invention, the network terminal located inside the structure and the network device are physically connected by way of an optical connector part. In a second mode of practising the invention, the network terminal located inside the structure and the network device are not physically connected.

A description will firstly be given of several examples of the first mode of practising the invention.

The network device of the present invention comprises (i) within a through-hole, a first optical connector part couplable to an optical fibre inside the structure; (ii) likewise within the through-hole, a second optical connector part couplable to an optical fibre outside the

structure; and (iii) a connector which connects the first optical connector part and the second optical connector part.

Alternatively, the network device can comprise a first optical connector part, a second optical connector part and a connector in the vicinity of the through-hole: in other words, in the region of the entrance and exit of the through-hole.

In the present invention, the connector advantageously comprises (i) connected to the first optical connector part, a first photoelectric converter for interconversion of optical and electrical signals; (ii) connected to the second optical connector part, a second photoelectric converter for interconversion of optical and electrical signals; and (iii) a connecting line for electrically connecting the first and second photoelectric converters. By converting optical signals to electrical signals, the frequency of the optical signals can be readily changed by electrical means. [3]

In the present invention, the connector is advantageously an optical fibre. Use of an optical fibre gives a compact and elegant design and simplifies the work involved in connecting.

Thus an optical fibre outside a structure and an optical fibre – which is a network terminal – located inside a structure are connected, for purposes of signal transmission, by way of this network device.

According to the first mode of practising the present invention, when connecting optical fibres for purposes of signal transmission, the network device is connected to a network terminal located inside the structure by way of an optical connector part. The optical connector part comprises for example a terminal optical connector part disposed at the end of an optical fibre, and a corresponding optical connector part which mates with the terminal optical connector part. [4] The optical fibre is thus connected to the photoelectric converter by way of the optical connector part. Two photoelectric converters, whereby respective optical fibres inside and outside the structure are connected by way of optical connector parts, are connected by a connecting wire which connects these photoelectric converters electrically. This connecting wire is advantageously one typically used for electrical wiring and made of a well-known metal.

Here, "terminal optical connector part" signifies for example the plug of an optical connector part, and "corresponding optical connector part" signifies for example the receptacle of an optical connector part. "Photoelectric converter" signifies a device for converting optical signals to electrical signals or for converting electrical signals to optical signals, and can for

example be a combination of a photoreceptive element such as a PIN photodiode or an avalanche photodiode, and a light-emitting element such as a light-emitting diode or a laser diode.

A more detailed description will now be given of optical fibre connection. When an optical fibre is to be newly installed in an existing structure such as a house, firstly the optical fibre is led from outside the structure to the vicinity of a through-hole which passes through to the inside of the structure, this through-hole being for example an existing vent hole in the structure or a sleeved hole for air conditioning pipework. Alternatively, a new through-hole may be provided.

Instead of single-mode or multi-mode silica fibre, the optical fibre used can be for example plastic optical fibre. As regards the configuration of the optical fibre, a double-core cable in which one core is used for transmitting and one for receiving is feasible. A single-core cable in which different wavelengths are used for transmitting and receiving is also feasible.

When leading the optical fibre into the structure, a terminal optical connector part is disposed on the end of the optical fibre and connected to a corresponding optical connector part, this having been formed on the photoelectric converter of the network device in the through-hole which passes through the wall of the structure from the outside to the inside. In other words, the terminal optical connector part and the corresponding optical connector part fit together and thereby effect connection. They therefore together constitute an optical connector.

The optical connector used is advantageously a miniature connector for accommodation in a duct. A Small Form Factor connector such as an MU, LC or MT-RJ style connector is desirable. However, other types of optical connector may be used.

It is also advantageous to fashion the network device so that an optical fibre and an electric power line for supply of electrical power are combined. That is to say, by using a cable in which an optical fibre and an electric power line are combined, the network device can be powered from outside the building, which is advantageous. The combination cable may be made by combining the optical fibre and the electric power line when the fibre is fabricated. The electric power line may be embedded within the protective sheath of the fibre cable, or it may run along the outside of the protective sheath. The electric power line is advantageously made of well-known metals.

Alternatively, instead of combining the electric power line with the optical fibre, it is feasible to lay it parallel with the optical fibre at the same time as the optical fibre is laid.

Because the electric power line is laid simultaneously, laying can be completed in one operation, which is advantageous.

A second mode of practising the present invention will now be described. In this second mode, the network terminal located inside the structure and the network device are not connected physically. That is to say, the network device is not connected directly to the network terminal located inside the structure.

The network device of the present invention [5] is disposed within a through-hole formed so as to pass through a wall of a structure, and serves to connect, for purposes of signal transmission, an optical fibre located outside the structure and a network terminal located inside the structure. This network device comprises, within the through-hole, (i) an optical connector part couplable to the optical fibre outside the structure; (ii) connected to the optical connector part, a photoelectric converter for interconversion of optical and electrical signals; and (iii) a wireless communication device electrically connected to the photoelectric converter and capable of sending and receiving radio signals to and from the network terminal inside the structure. The network device may also be disposed in the vicinity of the through-hole – in other words, in the vicinity of its entrance and exit – and may comprise, in the vicinity of the through-hole, the aforesaid optical connector part, photoelectric converter and wireless communication device.

Accordingly, in this second mode of practising the invention, connection to the network terminal inside the structure is not effected by using an optical connector part on the photoelectric converter, but indirectly, by the use of a wireless communication device – i.e., by transmitting and receiving optical signals or electrical signals. Here, the term "network terminal" is not restricted in meaning to an optical fibre, but rather signifies a wireless communication device or other apparatus for transmitting and receiving infrared or other optical signals, or radio waves or other electrical signals. It follows that by using signal transmission means which is a wireless communication device, optical signals or electrical signals are transmitted and received by propagation through space.

The use of a wireless communication device eliminates some wiring operations and cuts down on the space occupied by wiring. The network device is advantageously provided with a wireless communication device capable of sending and receiving optical signals to and from the network terminal. The device for transmitting and receiving infrared or other optical signals can for example be a combination of a photoreceptive element such as a PIN photodiode or an avalanche photodiode, and a light-emitting element such as a light-emitting diode or a laser diode. The photoreceptive element is capable of converting optical signals to

electrical signals, and the light-emitting element can convert electrical signals to optical signals. The network device is also advantageously provided with a wireless communication device capable of sending and receiving electrical signals to and from the network terminal. The device for transmitting and receiving electrical signals can employ a well-known radio wave transmitter and receiver.

The optical fibre outside the structure is connected in the same manner as in the first mode of practising the invention. Namely, an optical connector part – comprising a terminal optical connector part and a corresponding optical connector part – is connected to a photoelectric converter. The wireless communication device is connected to the photoelectric converter.

A detailed description will now be given. The photoelectric converter of the aforesaid network device has one or more ports for communicating with an apparatus located outside the structure, and one or more ports for communicating with an apparatus inside the structure. The ports for communicating with the outside of the structure are for example the ports in the portion of the photoelectric converter which converts to electrical signals the optical signals which have been input to the optical connector from the outside. On the other hand, the ports for communicating with a network terminal inside the structure are for example the ports in the portion of the photoelectric converter which converts electrical signals to infrared or other optical signals, and the ports in the portion of the photoelectric converter which converts electrical signals to radio waves or voltages. [6] Means for converting received electrical signals such as radio waves or voltages to optical signals may alternatively be provided in the aforesaid network terminal. Means for transmitting electrical signals without conversion to optical signals may also be provided. Moreover, in the case of the first mode of practising the invention, the functions of the photoelectric converter of the aforesaid network device preferably include, in addition to the media converter function for converting from optical signals to electrical signals (or *vice versa*), a hub function for converging electric lines from devices installed inside the structure, and a switching function. The network device may be located within the aforementioned through-hole or it may be exposed inside the structure in the vicinity of the through-hole but outside the hole.

Having the network device formed integrally in a sleeve that has been formed in the through-hole eliminates some construction work and simplifies and shortens the execution of the work, which is advantageous.

Embodiments of the present invention are described below.

Embodiment 1

This example serves to clarify the case where an optical fibre is led into a room of an existing apartment building, which is the structure.

In FIG. 1, which is a schematic sectional view of the situation where a network device has been disposed in a through-hole of a wall of the apartment building, referencing numeral 1 denotes the outer wall, 2 denotes the inner wall, 3 denotes a sleeve disposed in the through-hole which links the inside and the outside of the room, and 4 denotes a sealing member. Outside optical fibre 5 is separately arranged on the outside wall of the apartment building and leads up to the vicinity of sleeve 3.

After the installation of the outside optical fibre, plug 6 – which constitutes a terminal optical connector part – is fitted on-site to the end of the optical fibre. Plug 6 is then fitted into receptacle 7, which constitutes a corresponding optical connector part and which is thereby connected to plug 6. The second optical connector part comprises receptacle 7 and plug 6.

Photoelectric converter 9 – which is the outer photoelectric converter and which has been connected to receptacle 7 – is incorporated in network device 8. Room-side photoelectric converter 10 is incorporated in the other end of network device 8. Plug 11, which constitutes a terminal optical connector part and has been fitted to the end of room-side optical fibre 16, is connected to photoelectric converter 10 by way of receptacle 12 which constitutes a corresponding optical connector part, whereby optical signals can be transmitted and received to and from communication equipment inside the room. The first optical connector part comprises plug 11 and receptacle 12. Photoelectric converter 9 and photoelectric converter 10 are connected by metal line 14 which constitutes the connecting line. Electrical signals are transmitted between the two photoelectric converters.

Embodiment 2

The network device of this second example has the same configuration as the network device of the first example as regards the optical connector part of the outside optical fibre – namely, as regards the second optical connector part. However, it has a different configuration as regards the transmission of signals between the photoelectric converter etc. and a network terminal inside the building (i.e., it differs in respect of their connection method). FIG. 2 is a schematic sectional view of the situation where this network device has been disposed in a through-hole of a wall of an apartment building. In FIG. 2, constituent elements that are identical to those depicted in FIG. 1 are referenced with the same numerals.

In this second embodiment, optical signals that have been converted to electrical signals inside network device 8 are sent as radio waves to a network terminal (not illustrated) inside

the building from the antenna portion of wireless communication device 13 connected to photoelectric converter 10. A receiver (not illustrated) is connected to the network terminal inside the building, and received radio waves are converted to electrical signals.

Embodiment 3

This example serves to clarify the case where an electrical power line for supplying power to the network device is combined with an optical fibre to be led into a room of an existing apartment building, which is the structure.

In FIG. 3, which is a schematic sectional view of the situation where the network device has been disposed in a through-hole of a wall of the apartment building, referencing numeral 1 denotes the outer wall, 2 denotes the inner wall, 3 denotes a sleeve disposed in the through-hole which links the inside and the outside of the room, and 4 denotes a sealing member. Outside optical fibre cable 20 comprises optical fibre 21, a pair of electric power lines 22 and 23, and reinforcing fibres (not illustrated), and is separately arranged on the outside wall of the apartment building and leads up to the vicinity of sleeve 3. After the installation of the outside optical fibre, plug 25 – which constitutes a terminal optical connector part – is fitted on-site to end 24 of the optical fibre. Plug 25 is then fitted into receptacle 26, which constitutes a corresponding optical connector part. Plug 25 is provided with electrical contacts 27a and 27b for terminating the pair of electric power lines 22 and 23, and when plug 25 is fitted into receptacle 26 these make contact with electrical contacts 28a and 28b provided in receptacle 26, whereby electric power can be supplied to network device 8. Photoelectric converter 9 (constituting the outer photoelectric converter) connected to receptacle 26 is incorporated in network device 8. A plurality of room-side photoelectric converters 10 are incorporated in the other end of network device 8. Plugs 12 (constituting terminal optical connector parts) have been fitted to the ends of room-side optical fibres 11. [7] These plugs are connected to photoelectric converters 10 by way of receptacles 15 (constituting corresponding optical connector parts), whereby optical signals can be sent to and received from a plurality of communication devices inside the building. Photoelectric converter 9 and photoelectric converters 10 are connected by metal lines 14 (which constitute connecting lines) and via network controller 29 having hub and switch functions. Electrical signals are transmitted between the photoelectric converters.

Possibility of Industrial Utilisation

As has been described above, the present invention connects an optical fibre outside a structure and an optical fibre inside a structure by way of a network device disposed within a

through-hole which has been formed in a wall of the structure, thereby making it easy to lead an optical fibre into an existing structure.

Moreover, by disposing a network device having hub and switch functions in a through-hole of an outer wall, the present invention can also serve to construct a network inside a structure without sacrificing space inside the structure and without impairing the aesthetic appearance inside the structure.

TRANSLATOR'S NOTES

1. In the first embodiment, illustrated in FIG. 1, the "first optical connector part" referred to here turns out to be the combination of receptacle 12 and plug 11.

2. Likewise in the first embodiment, the "second optical connector part" is the combination of receptacle 7 and plug 6.

3. Sic.

4. The subsequent more detailed descriptions indicate that the "terminal optical connector part" corresponds to plug 11, and the "corresponding optical connector part" corresponds to receptacle 12.

5. The writer is here referring to the network device according to the second mode of practising the invention.

6. Sic.

7. The Japanese text calls these room-side optical fibres "16". I have changed this to 11 to bring the description into line with FIG. 3.

CLAIMS

1. A network device disposed within or in the vicinity of a through-hole formed so as to pass through a wall of a structure, and serving to connect, for purposes of signal transmission, an optical fibre located outside the structure and a network terminal located inside the structure, said network device comprising:

within or in the vicinity of the through-hole, a first optical connector part couplable to the network terminal, which is an optical fibre inside the structure;

within or in the vicinity of the through-hole, a second optical connector part couplable to the optical fibre outside the structure; and

a connector which connects the first optical connector part and the second optical connector part.

2. The network device claimed in Claim 1, wherein said connector comprises:

connected to the first optical connector part, a first photoelectric converter for interconversion of optical and electrical signals;

connected to the second optical connector part, a second photoelectric converter for interconversion of optical and electrical signals; and

a connecting line electrically connecting the first and second photoelectric converters.

3. The network device claimed in Claim 1, wherein said connector is an optical fibre.

4. A network device disposed inside or in the vicinity of a through-hole formed so as to pass through a wall of a structure, and which serves to connect, for purposes of signal transmission, an optical fibre located outside the structure and a network terminal located inside the structure, said network device comprising:

within or in the vicinity of the through-hole, an optical connector part couplable to the optical fibre outside the structure;

connected to said optical connector part, a photoelectric converter for interconversion of optical and electrical signals; and

a wireless communication device electrically connected to the photoelectric converter and capable of sending and receiving radio signals to and from the network terminal inside the structure.

5. The network device claimed in Claim 4, wherein said network device comprises a wireless communication device capable of sending and receiving electrical signals to and from said network terminal.

6. The network device claimed in Claim 4, wherein said network device comprises a wireless communication device capable of sending and receiving optical signals to and from said network terminal.

7. The network device claimed in Claim 2 or in any of claims 4 to 6, wherein an optical fibre and an electric power line for supply of electrical power are combined.

FIG. 1

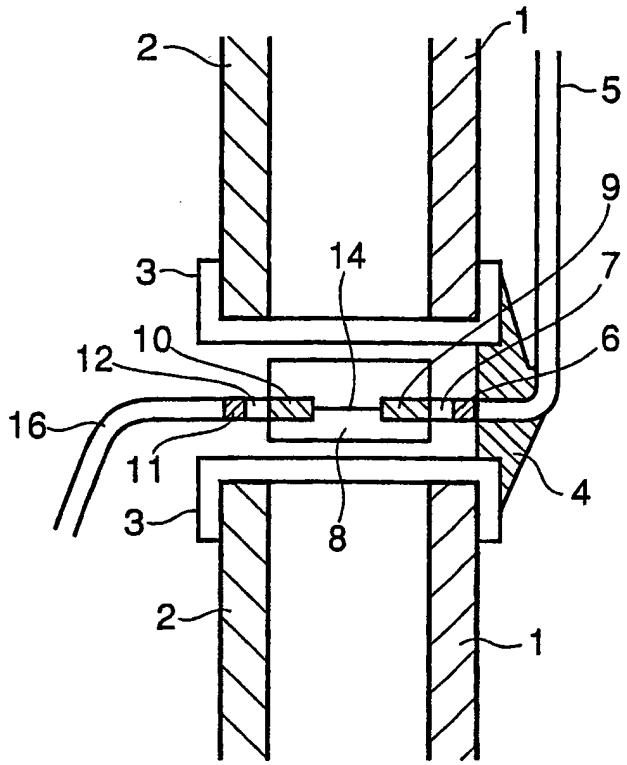


FIG. 2

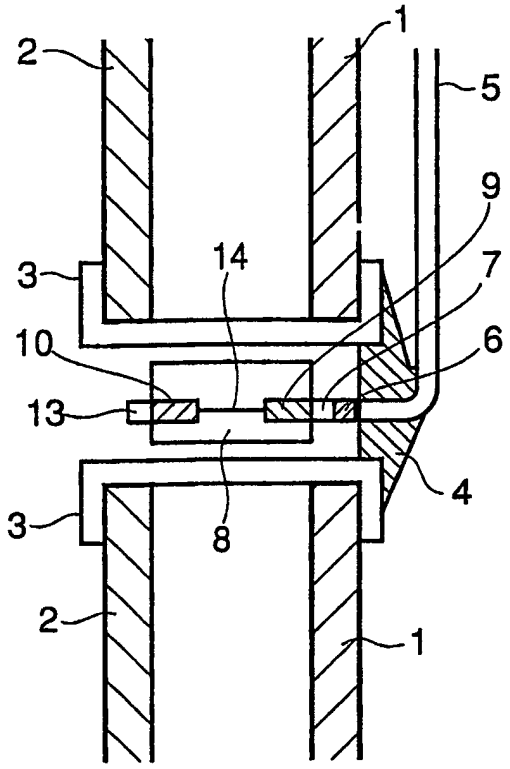
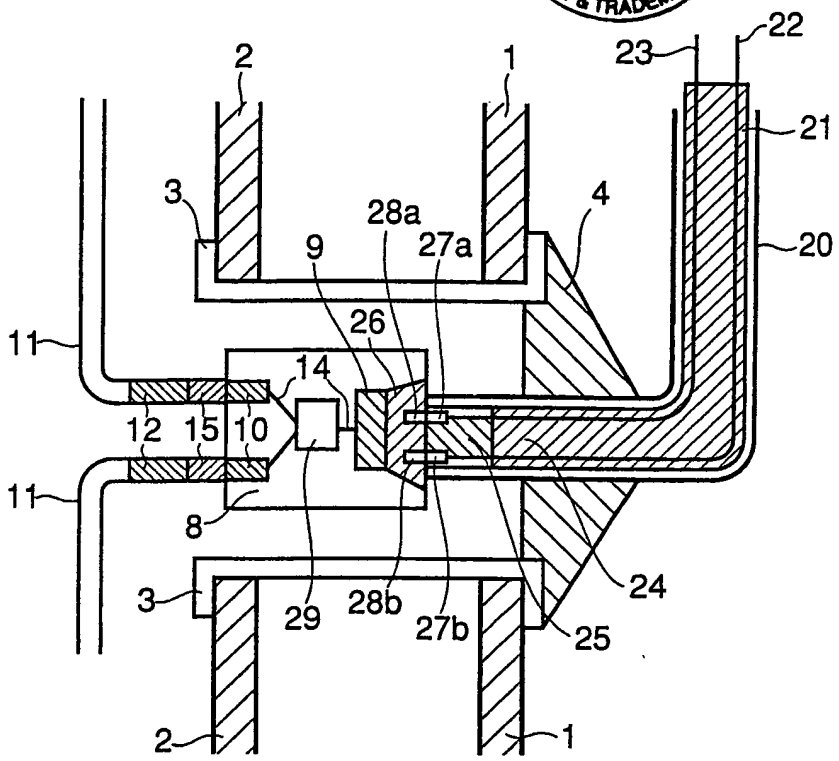


FIG. 3



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